building block of the cosmos. This element of the logo represents physics and chemistry.

3 and 9 – Two numbers out of 10. These represent arithmetic and mathematics. These 10 symbols can quantify different things from nil to anything thinkable or imaginable, e.g. trillion raised to the power of trillion – $(10^{12})^{\text{trillion}}$.

Genes – These are building plans (or intelligence) in biochemical forms for all living organisms from unicellular bacteria to worms and humans.

Ants – Ants moving clockwise and anticlockwise at different places and times (conceptually). They do not see each other and do not communicate by any means. But they are united since they fit into a scheme of things in a supervisor's mind or model. Similarly humans, to be precise, natives, living in different continents and time zones. They communicate within their groups only in different languages and are not in any contact. Still they fit into a scheme of global process, biologically and philosophically.

I – This symbolizes intellect, intelligence and instincts in three different mental types, viz. intellectuals, ordinary persons and animals, including foresters. Intellect is neuronally structured in the brain by long-term learnings and practices. Intelligence is what is expressed out in meaningful communications. Instincts are a product of 'mind-is-matter/body' state of life and growth, viz. native animals.

Co – This symbolizes the cosmos – all formed and/or organized matter (e.g. atoms, cells, stars) and energies of the universe.

hↃ – This symbolizes chaos – all unformed, unorganized particles, plasma, energies and unknown things.

U – This symbolizes the universe; not known or conceived fully, but by cosmos and chaos together. The central part of the logo consisting of intellect, cosmos, chaos and the universe can be considered as a seal of the universe.

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Nobel Prize for artemisinin research: Indian side of the story

The Nobel Prize for Physiology or Medicine 2015 awarded to Youyou Tu is heartening to all the researchers around the globe who have been involved in the application of traditional systems of medicine for developing modern methods of therapy. Particularly, it is a matter of joy and satisfaction for artemisinin researchers across the globe, including those in India. The main reason for this highest scientific recognition to Tu and her outstanding work stems from the success of *Artemisia annua* extracts, artemisinin and its derivatives in saving the life of millions in Asia and Africa.

Realizing the enormous anti-malarial potential of sesquiterpene lactone compound (artemisinin) in the early eighties, Nitya Anand (the then Director of CSIR-CDRI, Lucknow) brought seeds of *A. annua* to India. Akhtar Husain (the then Director CSIR-CIMAP, Lucknow) and his team were successful in growing *A. annua* at the experimental farm of CIMAP in Kashmir[1]. The plant was soon acclimatized for cultivation at the experimental farm of CSIR-CIMAP, Lucknow, and later in the plains of Uttar Pradesh. Since the available variety of *A. annua* had very low artemisinin content (less than 0.1%), an intensive breeding programme was launched at CSIR-CIMAP to increase the artemisinin content up to 0.8–1.0%.

Due to technological interventions of CSIR-CIMAP, including development and popularization of artemisinin-rich plant varieties, and improved processing technologies (27 patents, including 14 in the US), the cost of production of artemisinin was brought down from about Rs 40,000/kg to about Rs 10,000/kg. Optimization of the processes for extraction and purification of artemisinin at CSIR-CIMAP led to the production of kilogram quantities of artemisinin for its chemical transformation to more soluble and stable derivatives (Figure 1). While scientists at WHO focused on β-artemether, those at CSIR-CDRI and CSIR-CIMAP teamed together to initiate work on α,β-arteether[2]. Extensive pharmacological investigations and clinical trials on α,β-arteether at CSIR-CDRI eventually led to its development as a drug for the treatment of severe falciparum malaria. These dedicated attempts then led to a series of patents (27, including 14 US patents) and eventually the technology for the production and distribution of indigenously developed anti-malarial drug α,β-arteether was transferred to M/s Themis Medicare, Mumbai and distributed as 'E-mal'. In 2007, α,β-arteether was included in the National Drug Policy for the control of malaria by the Ministry of Health and Family Welfare, Government of India.

The technology package for cultivation of improved varieties of *A. annua* developed by CSIR-CIMAP was licensed to several pharma companies to link farmers for assured price cultivation of *Artemisia* in a public-private-partnership (PPP) mode, not only to enhance industrial productivity and business, but also to enhance rural incomes. Later, M/s IPCA Laboratory, Ratlam entered into consultancy agreement with CSIR-CIMAP, and introduced contract farming of the 'CIMAP-Arogya' variety of *A. annua* covering about 2700 acres of land in Uttar Pradesh, Uttarakhand, Gujarat and Madhya Pradesh by 2012–13. It was demonstrated that cultivation of *A. annua* provides a high return (Rs 65,000 per hectare) to the farmers in a short span of about four months[3]. As a consequence of this synergy among the scientific teams

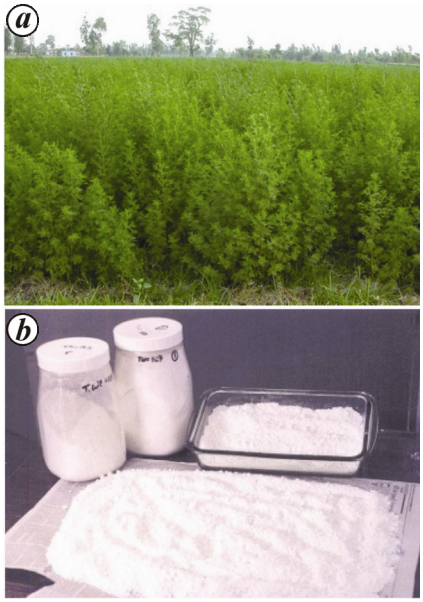

Figure 1. ***a***, *Artemisia annua* (field view). ***b***, Artemisinin isolated at the CSIR-CIMAP pilot plant in Lucknow.

Table 1. Major landmarks in *Artemisia annua* research

1984	Introduction of *Artemisia annua* in India.
1989	Development of improved variety 'Asha' of *A. annua*.
1998	CSIR Shield for Process Technology jointly awarded to CIMAP and CDRI for development of the processing technology for α/β-arteether – a new, fast-acting anti-malarial for treatment of complicated and uncomplicated *Plasmodium falciparum* malaria.
1999	Development of artemisinin-rich variety Jeevanraksha and its dedication to the nation on the first National Technology Day (11 May 1999) by the then Prime Minister of India Atal Bihari Vajpayee.
2005	Development of variety CIM-Arogya through marker-assisted breeding.
2005	Launching of CIMAP *Artemisia* Biovillage programme with industrial participation.
2006	Inclusion of *A. annua*-related technology as one of the most important technologies of the year by the then President of India A. P. J. Abdul Kalam in his National Technology Day address to the nation.
2012	CSIR Technology Award–2012 for development and commercialization of anti-malarial drug plant *A. annua* technology package facilitating industrial growth, societal health and rural prosperity.

of CSIR-CIMAP and CSIR-CDRI, farmers and pharma industry, the cost of treatment of cerebral/drug-resistant malaria came down several-fold, thus making treatment of the disease affordable to the poor in Asia and Africa, and saving millions of lives. This drug is presently being exported to several countries, including Nigeria, Ghana, Congo, Kenya, Zambia, Malawi, Rwanda, Myanmar and Cambodia. According to G. P. Dutta (formerly at CSIR-CDRI), nearly 30 pharmaceutical companies in India are producing α,β-arteether (three-dose) injection for meeting indigenous needs as well as for export to African countries. Recognizing the immense value of these contributions, the joint endeavour of CSIR-CIMAP and CSIR-CDRI was duly recognized by the 'CSIR Process Technology Shield' in 1998. Later, CSIR-CIMAP was also awarded the 'CSIR Technology Award–2012' for the development and commercialization of anti-malarial drug plant *A. annua* technology package facilitating industrial growth, societal health and rural prosperity (Table 1).

The immense value of artemisinin to mankind is highlighted by its ability to save millions of lives in Asia and Africa. It is in this context that the researchers at CSIR-CIMAP and CSIR-CDRI feel elated for their role in bringing the benefits of *A. annua* to the service of mankind. The case of artemisinin research also demonstrates the potential of Indian scientists to translate the results of basic research into making a life-saving drug to providing affordable healthcare to the poor. It is hoped that this example would convince our policy planners that Indian scientists have the desired level of concern, commitment and grit for solving the problems of our country. It may not be out of place to underline that the 'proof' of any scientific discovery is more important than its 'concept/principle'. This is why the Nobel Prize to Arthur Kornberg (in 1959) was given away three years ahead of Watson and Crick (in 1962) for proving the functionality of the double-helix model (discovered by Watson and Crick in 1953).

1. Singh, A. K., Kaul, V. K., Mahajan, V. P., Singh, A., Mishra, L. N., Thakur, R. S. and Husain, A., *Indian J. Phram. Sci.*, 1986, **48**, 137–138.
2. Vishwakarma, R. A., Thakur, R. S., Dutta, G. P. and Bajpai, R., Patent No. 173947 (Pat. Application No. 1070/DEL/90), 1994.
3. Kumar, S., Suresh, R., Verma, D. K., Dangesh, A. and Tomar, V. K. S., *Curr. Sci.*, 2015, **109**, 1237–1239.

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Disaster victim identification – a need to create zone-wise scientific working groups

More than 8600 lives were lost and 2.8 million people were displaced in a series of earthquakes that rocked Nepal in April–May 2015 (ref. 1). Unfortunately, hundreds of thousands of people are killed in disasters such as floods, cyclones, earthquakes, tsunamis, fires, storms, landslides, airplane crashes, road and train accidents, terrorist attacks, bomb blasts, etc. The year 2014 witnessed several natural disasters throughout the world which were thought-provoking in terms of the number of casualities[2]. For such events, the recovery and identification of the disaster victims is important from humanitarian as well as legal point of view. Disaster victim identification (DVI) is the process of identifying the victims of mass disasters/mass fatality incidents through the application of scientifically proven techniques. The positive identification of the victims of mass fatality incidents is greatly expedited by the advent of modern technologies such as DNA typing, comparison of ante-mortem and post-mortem records using forensic odontological techniques, fingerprints and other anthropological methods. The DVI process can be long and time-consuming as it depends upon the nature of the mass fatality incident. The main aim of the DVI team is to correctly identify human remains; therefore, the team may apply a number of identification methods depending upon the available parts and condition of the deceased and the human remains. The commonly used methods include DNA profiling of the human remains, finger-